Wilder (B. G.) From the Author.

Box 288

CONTRIBUTIONS

TO THE

COMPARATIVE MYOLOGY

OF THE

CHIMPANZEE.

By BURT G. WILDER.

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TO THE

COMPARATIVE MYOLOGY OF THE CHIMPANZEE.

By Burt G. Wilder.

Through the kindness of Prof. Jeffries Wyman, I was enabled last winter to dissect one side of a young male Chimpanzee, *Troglodytes niger*, about two feet in height; as it had been kept in alcohol for two or three years, it could be examined more at leisure than a fresh specimen. The dissection was very carefully made, and with special reference to the differences in the muscular system from that of man. Believing the mere facts in Anatomy or any science to be in themselves worthless till so grouped and studied as to exhibit the uses or functions which they represent, I have constantly endeavored to detect the *meaning* of the differences in size, number, and arrangement between the muscles of the Chimpanzee and those of man, and with this view have dissected portions of six other Quadrumana of the genera Macacus, Cynocephalus, and Ateles, and several lower animals, using also for comparison the published or MS. notes of a large number of other dissections. (See list at the end of this paper.) I will speak first of some muscles whose functions are chiefly local, and then more in detail of the muscular system as adapted to the climbing habits of the Quadrumana.

Occipito-frontalis. The apes have been generally supposed to possess the power of moving the eyebrows and scalp, which man does by means of this muscle; in him the two muscular bellies are short, the greater part of the skull being covered by the thin aponeurosis which connects them. I have dried and preserved the right half of this muscle from the Chimpanzee which I dissected; the fleshy fibres are proportionally much longer than in man, and seem to meet upon the vertex; the occipital portion is quite fleshy and distinct, but the frontal portion is thinner and more closely united with the thick skin, so that, commencing in that region, one might very easily overlook it, as I did at first. Tyson and Traill say they could not find it in their specimens, and no other authors mention it, except Prof. Owen, who found it in an Orang (*Simia Satyrus*), and partly in a Chimpanzee. (4.) There were evidences of it in a Cynocephalus and in the Macaci which I dissected, but I did not trace it in its whole extent.

The muscles of the ear have been as little noticed by anatomists; the ear of this specimen had been cut off before I dissected that region, so that I am not positive as to the insertions into it; but in the places of the *Attrahens* and *Retrahens aurem* were series of muscular fibres converging towards the ear, their upper borders touching the lower border of the *Occipito-frontalis;* they seemed to be more extensive than in man. On the upper surface of part of the parietal and frontal portions of the *Occipito-frontalis* may be seen a thin layer of muscular fibres, about two inches in width, near the sagittal suture, thence converging downward towards the ear. If this represents the *Attollens aurem*, it is much more extensive than in man.

Cutaneous muscles. In the Chimpanzee, as in the Gorilla and Orang, the *Platysma myoides* is rather thicker than in man, but I could find no cutaneous muscles upon the trunk as in the lower animals. There was a distinct *Der-*

mo-humeralis in each of the two Cynocephali and three Macaci which I dissected, and it is not mentioned as absent in the others. It is generally inserted over the tendon of the *Latissimus dorsi*, and would thus serve either to wrinkle the skin, or to assist the latter muscle to flex the humerus, as in climbing.

Digastricus. The anterior belly is much broader than in man, being composed of two portions, — one external, next the jaw bone, rounded and more directly connected with the tendon, — the other internal and twice as broad, reaching to the middle line to join that of the opposite side. The two muscles fill the space between the rami of the jaw.

Sterno-mastoid. Wholly distinct from *Cleido-mastoid.* Occipital portion very broad, the aponeurotic attachment reaching from just behind the ear to the middle line on the superior occipital crest. Thence downward it gradually becomes narrower, thicker, and more rounded, crossing the *Cleido-mastoid* to be inserted by a short, round tendon into the manubrium, as in man.

Cleido-mastoid. This is smaller than the preceding, and the reverse in shape, the small end being above, and attached to the skull just within the anterior edge of the *Sterno-mastoid*, while the lower end is wider and inserted into the upper border of the clavicle, near the sternum. In the Gorilla, according to Duvernoy, the sternal portion of the *Sterno-cleido-mastoid* is very small, the whole appearing as one muscle, which is almost wholly attached to the clavicle, and there are not two separable portions; but in Prof. Wyman's specimen it resembled that of this Chimpanzee.

Trapezius. I noticed no difference in this from the human, except that its lower border, instead of overlapping the upper border of *Latissimus dorsi*, seemed to be continuous with it, as mentioned by Vrolik, who says that

this connection does not exist in other apes. Tyson's plate is not very distinct, but he does not say that it differs from the human. In the Gorilla, according to Duvernoy, it is as in man.

Rhomboidei. In the Quadrumana generally, these form but one muscle. In the Orang, and in the Inui and Cynocephali, (8.) the single muscle is attached to the occiput, thus serving to support the head.

Levator-anguli-scapulæ. Did not differ from the human; in a Cynocephalus and Macacus it was continuous below with the *Serratus magnus*, of which it would thus seem to be merely a continuation. In the Macacus it arose from the transverse processes of all the cervical vertebræ, and perhaps from the occiput and first dorsal vertebra.

Levator claviculæ (Tyson), Trachelo-clavicular, or Trachelo-acromialis. This muscle is not found in man, but appears to exist under some form in most of the lower animals. In this specimen it was quite strong, but I did not see its origin, which is generally from the transverse processes of some of the upper cervical vertebræ.

Serratus magnus. Composed of two fleshy parts, with an intervening thin portion. The superior part seemed to arise from the first and third ribs, thence becoming wider, to be inserted into about an inch of the upper angle and posterior border of the scapula. The inferior portion is much larger, arising from the eight ribs below the third, thence narrowing to its insertion into the lower angle and part of the posterior border of the scapula, without any tendon. I did not see that the intervening thin portion was anything more than a thin membrane.

Subclavius. I am quite sure that it was present, but did not note its connections. Mr. Moore thinks he saw it on the right side of this specimen. It is generally present in Quadrumana, and larger than in man, in accordance with the greater mobility of the shoulder.

Costo-coracoid ligament. Connects the cartilage of first rib near the sternum with the coracoid process. Duvernoy thinks that this takes the place of the *Subclavius* in Gorilla; but they both existed in this Chimpanzee.

Coraco-brachialis. Does not seem to reach the coracoid process at all, except through the tendon of the short head of the *Biceps*, to which, and to the upper part of the muscle itself, its fleshy fibres are attached; its insertion, I think, was not more than one half an inch long, one third down the humerus. In Prof. Wyman's Gorilla this attachment was from the surgical neck as low down as the middle of the humerus.

Before describing the muscles employed in climbing, let us first consider how far this principal mode of locomotion of the Quadrumana differs from that of man.

The Quadrumana are all more or less perfectly adapted for climbing; but as those of the old world form two groups, — the Anthropoids, including the Chimpanzees, Orangs, and Gibbons, with very long and powerful arms and short legs, fitting them well for climbing, but poorly for walking; and the Baboons and Monkeys, (Cynocephali, Macaci, &c.) whose limbs are of nearly equal length and power, and who climb or walk on all fours with about the same facility, — so in the new world are two corresponding groups, the Howling-Monkeys, the Ateles, &c., with a long and generally powerfully prehensile tail, all being very agile climbers; and the Cebidæ, Sakis, and others whose tail is not prehensile, and who go often upon all-fours. So much do the Anthropoids resemble ourselves in external form and in their attitudes, as we see them in captivity or represented in books, and so nearly also does their internal structure correspond with our own, that we are very apt to overlook the radical distinction in their mode of locomotion, and to believe that in this as in other respects they form the physical transition between the lower

animals and man. *We* walk upright upon the earth, and our whole frame is perfectly balanced in that position; we are supported from below by comparatively narrow pedestals; our whole weight is in direct opposition to the erect position, and, as soon as we declined from it, would force us to the earth but for the preponderance in the back and legs, of the extensor over the flexor muscles. The position of the *ape* in nature is just the reverse: he hangs and moves about among the trees by means of his long arms, being thus sustained, not from below, but from above; and his weight would soon bring him to the earth but for the immense power of the *flexor* muscles in the arms. In our arms, and in the legs of the ape, the two systems of muscles are more nearly equal. Our legs are solely for locomotion, our arms solely for prehension, and both present the perfection of structure which would naturally attend so high a degree of specialization of function; but both the upper and lower limbs of the ape may be employed as organs of either support or prehension, and we therefore remark in them a corresponding want of complete adaptation to either of these functions; yet these so diverse motions of man and apes are performed by almost identical muscles, while in the bird, which, like man, walks upon two legs, with a very characteristic motion of the anterior extremities, the muscles are with great difficulty homologized with the human. We see also that in both man and ape the greatest weight of the body is placed nearest the organs of support, which is a further proof of the inability of the former to climb, and of the latter to walk, with ease; and the depressed head of the ape, and the proportions of the neck, which is shorter than in man compared with the length of the arms, also offer the least hindrance to the free suspension and movement of the trunk by the arms. The great length of the ape's arm, especially below the elbow, however useful in climbing, deprives him in a measure of the

facility we possess of touching with the fingers every portion of the body; and we should hardly wish our arms so long as to render the most convenient way of scratching the middle of the back, passing the hand between the legs, and up behind to the point desired, as has been said of one species.

So far as the arms are concerned, the climbing of the ape consists in their alternate extension towards and contraction from some point above, thus elevating the body to it. The shoulder is much more movable than in man, and has an additional elevator, *Levator claviculæ*. It is depressed by the lower part of the *Trapezius*, by the *Serratus magnus*, *Subclavius*, and *Pectoralis minor;* this latter is quite variable in its insertion, which is sometimes into the coracoid process as in man, and sometimes into the great tuberosity of the humerus; in this Chimpanzee the former was the case on the left side, but the latter on the right side. In the Gorillas of Profs. Wyman and Duvernoy the muscle was composed of two portions, of which the upper was inserted into the coracoid process, and the lower into the tendon of the short head of the *Biceps*, so that when the arm was raised, it might act as a flexor of both humerus and fore-arm. In the lower species, the muscle is generally longer than in man, and more or less subdivided, and its insertion is usually into the humerus. The arm is raised from the side by the *Deltoid*, which is extremely thick and powerful, as is required by the length and weight of the limb; there is also an additional infraspinous portion of this muscle arising from the fascia of the *Infra-spinatus* and from the lower third of the anterior border of the scapula, which would better enable the Chimpanzee to swing the arm backward. The *Deltoid*, *Supra* and *Infra-spinati*, *Teres minor*, and *Subscapularis* are a great protection to the joint.

The humerus is depressed, or, the hand being fixed, the

body is raised by the *Pectoralis major* in front, the *Latissimus dorsi* behind, and the *Teres major* arising from the lower half of the anterior border of the scapula between them. The three are very thick and strong; the sternal portions of the *Pectorales majores* nearly touch on the middle line, but there is no division between them and the clavicular portions, though the fibres cross before their insertion as in man. The tendons of these three muscles pass round the *inside* of the humerus towards the upper surface, so as by their contraction to throw the elbow outwards, and keep the thumb and radial side of the forearm inward and upward, which is obviously the most advantageous position. In the lower species the *Dermo-humeralis*, described above, acts as a second *Latissimus dorsi*, though of course much more feebly. The scapular head of the *Triceps*, though part of the extensor, is nevertheless, when acting alone or with the other flexors of the humerus, a powerful aid in climbing, its extensor power being counteracted by the flexors of the forearm, which act at a greater mechanical advantage, so that it can then act only as a flexor of the humerus.

In man there is occasionally found as an anomaly, a muscular slip on the inside of the arm, from the tendon of the *Latissimus dorsi* to some part of the elbow; in most of the Quadrumana, and in very many other animals, this muscle is constantly present, though varying as to size and insertion in different species; it does not seem to have been described with much accuracy; in the lower animals it is often so large as to be called the fourth head of the *Triceps;* in the Quadrumana it is generally named the "*slip from Latissimus dorsi to elbow*," with a conjecture that it may be of some use in climbing; this it never could be, but the reverse, acting as part of the extensor; but even if inserted into the olecranon or upon the *Triceps*, as it sometimes is, it would be of the same use in

climbing as the scapular head of that muscle; but in a large number of cases it is attached to or over the internal condyle of the humerus, thus acting only to draw the arm and body together, without at all interfering with the simultaneous flexion of the forearm at the elbow. Duvernoy describes it in the Gorilla under the name of "*Dorso-epitrochlien*," and he seems to have understood its true function better than any one else. In the lower Quadrumana, while on all fours, as in Quadrupeds, this muscle simply helps to retract the fore-leg; in the cat which climbs, and in the same way as we do, by contracting the whole limb, it is inserted into the internal condyle; but in the Angora Goat, whose so-called climbing is merely a tall kind of walking, it is almost wholly attached to the long olecranon, tending thus to extend or straighten the whole limb at the same time that it pulls it backward.

The muscles which flex the arm at the elbow are the same as in man, — *Biceps*, *Brachialis anticus*, and *Supinator longus*. The two heads of the first are distinct to within an inch of the insertion, and the coracoid head is the larger. The *Brachialis anticus* is not easily separable into two parts, or as easily into several. In the *Supinator longus* we notice at once a feature which exists also in the flexors of the leg; its origin is from the two inches below the middle of the humerus, thus as high as the *Brachialis anticus*, and much higher than in man; while this disposition of the flexors mars the symmetry of both elbow and knee; combined with the constant partial flexion of the arm and leg it confers upon the ape greater readiness and power of contraction. The length of the belly of the *Supinator longus* is to that of the tendon as five and a half to one and a fourth.

From the direction of the force, the *Supinator longus* is a very feeble supinator, much more so than the *Biceps*, which also can turn the palm fairly upward, while the for-

mer can only bring the thumb or radial side of the hand uppermost; then continuing to act, it is a simple flexor of the forearm, with of course more power the higher it is attached upon the humerus; in fact the *Supinator longus* bears the same relation to the humerus when the hand is fixed, as in climbing, that the *Biceps* bears to the forearm when the shoulder is the fixed point. Both muscles may act as either flexors or supinators; in the former case their effect as supinators must be counteracted by the *Pronator teres*, which then is also a flexor, and in the latter case the *Triceps* may be felt to contract to prevent flexion, and also to fix the ulna. The gradual disappearance in the Quadrumana of the power of rotating the forearm, which is so complete in man, is well described by Vrolik (7, page 30). The most natural, and therefore the most useful position of the forearm in the climbing Quadrumana, is midway between pronation and supination, when the *Supinator* acts freely as a flexor. While dissecting an Angora goat last winter, I was much interested to observe that the *Biceps* had two distinct tendons of insertion, of which one, representing the single tendon of man and in the Quadrumana, ran round the neck of the pronated radius, to be attached to its lower surface, while the other *extra* tendon was inserted at once into the upper border of the bone; this double tendon, adapted to the flexion of the forearm in its state of permanent pronation, is a good example of the adherence to a general plan, with the addition of a part for special use, or, from the opposite point of view, of the total disappearance of a part when no longer needed. I found the same structure in a young sheep, but have never noticed it in the Carnivora. The flexors and extensors of the wrist do not differ from those in man, except that the *Flexor ulnaris* is larger, as also the pisiform bone to which it is attached. In the Chimpanzee, as in man, the *Flexor carpi ulnaris* is more powerful than the *Flexor carpi radi-*

alis; the former is clearly the one which we use in the more forcible movements of the hand at the wrist, in striking a blow, or in reaping with a sickle; it is also full as good a supinator as the *Supinator longus*, and in nearly all actions requiring forcible supination, as turning a handle, &c., the hand is flexed to the ulnar side at the same time.

It is a general rule, that two contiguous segments of a limb are flexed in opposite directions, as is well shown in the human lower extremity, where thigh, leg, foot, and toes all bend thus contrary to each other, the flexor muscles of one segment lying, of course, on the same side of the limb with the extensors of the segment next below. This holds good in the leg and upper arm of most animals as well as man, but in nearly all, the hand and fingers, and, if the hand is supinated as in man and Quadrumana, the forearm also, appear to be flexed or extended in the same direction, so that two, or even three groups of muscles, which by their contraction shorten the arm, lie all upon the same side of the limb, though attached to three contiguous segments, — forearm, hand, and fingers. But to carry out the idea of "antero-posterior symmetry" or antagonism between the corresponding segments of the fore and hind limbs, the supinated hand must be placed palm downward, with the fingers pointing backward, when of course the muscles now called *extensors* of the wrist or hand will become the *flexors*, and vice versa, and the contiguous segments will be flexed in opposite directions. During the earlier fœtal periods the hand is in a state of supination, and afterwards becomes pronated, remaining so through life in the common Quadrupeds, only some, as the higher Carnivora, the Quadrumana, and especially man, having the power of freely rotating it back to its original condition, which, of course, is more likely to illustrate the true morphology than any afterwards ac-

quired. Therefore, the muscles on the front of the forearm attached to the wrist are *morphologically extensors*, although they will probably retain the *functional* name of *flexors*, since by their contraction they shorten the limb. In the leg of man, the above rule obtains even as to the slight lateral deflection at the joints, for the hip stands outward, the knee inward, and the ankle again outward, so that the sole of the foot may be *inverted* more easily than *everted*, as is more strikingly shown by the permanent condition of the foot in the ape, in whom, however, the rule is infringed by the peculiar outward curvature of the whole limb for greater facility in climbing. So when the arm is placed in the position indicated above, the shoulder stands outward, the elbow inward, and the wrist again outward, the hand bending more naturally to the ulnar than to the radial side; and accordingly we find the *Flexor carpi ulnaris* more powerful than the *Flexor carpi radialis*, and the hand of the Bird is permanently flexed to the ulnar side. The use of the "antero-posterior symmetry" between scapula and ilium, humerus and femur, forearm and leg, in the common Quadrupeds, for better balancing the body when at rest, is evident; but since the animal when moving goes forward, the hand is pronated so that the two lower segments, which are often much elongated, both bend backward, affording a more extensive motion in that direction for propelling the body forward. But in the hind leg the segments below the knee, and indeed below the hip, possess little separate motion, the entire limb swinging nearly as a whole.

The tendons of the deep common flexor of the fingers, (*Flexor profundus digitorum*) were so short as not to permit the simultaneous extension of both hand and fingers; the latter could be straightened only when the former was at right angles with the forearm, and when I bent the hand back into a straight line the fingers closed tightly

upon mine. The advantage of this to a climbing animal is at once apparent; the hand having been placed upon a branch, the mere weight of the body would cause the fingers to close upon it like hooks without muscular exertion, and they would retain their grasp till the strain was relieved by means of the other limb. How else can we explain the power which some Orangs have been said to possess, of swinging upon a rope by the hands alone, for an hour at a time? It also readily accounts for the Anthropoids not being able to apply their palms to the ground when on all fours, but being obliged to rest on the knuckles. I have never seen any direct reference to this structure, but it has always been remarked that the digits of both hands and feet of the Anthropoids are generally flexed, giving them a hook-like appearance. By a similar structure, though not nearly so marked, the human hand may be bent backward a little farther when the fingers are flexed than when they are straight; and, the reverse of what exists in the Chimpanzee, owing to the shortness of the *extensor* tendons, man's hand and fingers cannot be flexed far together, but by bending forward the closed fist the fingers are gradually forced open.

In general, the muscles lying upon the forearm differ from our own in being less distinct from each other, and in remaining fleshy often to the wrist, allowing more extensive movements, but detracting much from the elegance and pliability of the limb.

Extensor communis digitorum. May be separated into three fleshy parts to above the middle of the arm, and the part supplying the index finger still higher; this becomes tendon at the wrist, the middle portion about an inch higher, while that going to the ring finger is the largest, and continues fleshy below the end of the ulna; the tendon of the middle one is the largest. The *Extensor minimi digiti* is separate from the preceding as high as the part

supplying the index finger; it is slender, but continues fleshy below the wrist. Neither Mr. Moore nor I found any tendon from the *Extensor communis* to the little finger, nor does Vrolik mention it; but there was such a tendon very distinct in Duvernoy's Gorilla. The *Extensor proprius indicis* was as in man, but perhaps arose a little lower down on the ulna.

Palmaris longus and P. brevis. These are not constantly present in the Quadrumana; the former was in this Chimpanzee, as in Vrolik's, but it does not exist in the Gorilla according to Duvernoy, and Prof. Wyman does not mention it. It was wanting in one arm of Traill's Chimpanzee, but present in the other, and Mr. Moore found it in the right arm of Ateles Paniscus, while Mr. Folsom did not in the left. I did not see any *P. brevis*, but Vrolik says it existed in his specimen. It was present in the Gorilla of Duvernoy, but not in that of Prof. Wyman.

Flexor sublimis digitorum. This in the left arm was as in man, but in the right arm Mr. Moore is certain that the ring finger received two tendons, and the little finger none. The *Flexor profundus digitorum* is very thick and strong. As in Duvernoy's Gorilla, the portion supplying the index finger is separate from the rest, and joined with the long flexor of the thumb; the remainder occupies the place of the *entire Flexor communis* in man. (For the shortness of its tendons, see above.) The *Flexor proprius indicis et pollicis* arises from the radius, in the position of the *Flexor pollicis only* in man; it sends a strong tendon to the index finger; from the lower surface comes off a slender tendon which is inserted into the base of the second phalanx of the thumb. The thumb has thus become merely an aid in the grasping of the fingers, with little or no independent action. A like arrangement existed in Duvernoy's Gorilla, but in Prof. Wyman's Gorilla, and in his and Traill's Chimpanzees, this muscle did not exist separate from the

rest. Tyson says that the muscles of the thumb differed not from the human, but there was no tendon to the thumb in Vrolik's specimen. In the lower Quadrumana, when there is any tendon for the thumb it generally comes from the common flexor; there was none in Ateles Paniscus, whose thumb is rudimentary; in the Howling-Monkey there were four tendons, — one to the thumb, but none to the little finger.

The short muscles of the thumb were all present, but thinner and less distinct than in man; they exist in the Gorilla and Howling-Monkey, but not in Ateles Paniscus, except perhaps a very little rudiment. The *Extensor longus pollicis* (*secundi internodii*) is present generally in the Quadrumana. The *Extensor brevis pollicis* (*primi internodii*) was quite as large as the preceding, not smaller as in man, and was inserted into the radial side of the base of the metacarpal of the thumb, as in the specimens of Wyman and Vrolik; Tyson says the insertion was as in man. In the Gorilla, Prof. Wyman does not mention any peculiarity; and Duvernoy says it is as in man, but that it is wanting in the Chimpanzee, the *Abductor longus* taking its place; in this Chimpanzee it was confounded with the latter only above. It was wanting in the Howling-Monkey, and in Prof. Wyman's Cynocephalus was joined to the *Abductor*, which goes to the trapezium. The *Abductor longus pollicis* (*Extensor ossis metacarpi*) was inserted into the trapezium, as in the specimens of Prof. Wyman and Vrolik, and in Prof. W.'s Cynocephalus, but in the Howling-Monkey it is as in man. In the left arm of Ateles Paniscus Mr. Folsom says it was present, but Mr. Moore thinks that in the right arm it was united with the *Extensor brevis*, with a double tendon attached to both trapezium and metacarpal bone. See Duvernoy for his views as to the homologies of these three muscles.

All the muscles of the little finger were present, as also

in the Gorilla. The *Lumbricales* were like the human, except that the slip supplying the little finger did not arise from the tendon of the deep flexor of that finger, but only from that of the ring finger. The *palmar Interossei* were much, and the *dorsal Interossei* little, developed.

I dissected the muscles of the back and of the abdomen only enough to see that the former, as extensors, were weaker than in man, while the latter were stronger, both as very important flexors of the trunk, and as supports to the viscera, in the creature's semi-erect position.

Psoas parvus. Absent on both sides of this individual. Not mentioned except by Tyson, who says it was larger than in man. Present in the Gorillas of Wyman and Duvernoy, in the Howling-Monkey, in Macaci, and Cynocephali.

Quadratus lumborum. Shorter than in man, as the *Psoæ* and *Illiacus* are longer. Mentioned only by Duvernoy as in the Gorilla, and by Wyman as in the Howling-Monkey, where it is more slender than in man, and arises from the transverse processes of the four upper lumbar vertebræ, and from the body of the first.

Quadratus femoris. Longer and narrower than in man, as noticed by Owen in the Orang, and naturally from the downward projection of the ischium.

I am quite sure that the other rotators were present, but at the time of the dissection I was not sufficiently familiar with their limits in man to compare them with much certainty.

Pectineus and three Adductors. These are present, but more intimately connected than in man. They form a very large fleshy mass, and are inserted down the whole length of the femur, the principal portion of the *Adductor magnus* being attached by a strong tendon to the internal condyle. They would not only adduct the thigh strongly, as in climbing, keeping the inverted sole against the tree,

but from the backward projection of the ischium, the *Adductor magnus* especially becomes a powerful extensor of the limb for leaping.

Psoas magnus. Arises from the four lumbar vertebræ, and perhaps from the thirteenth dorsal; some fibres also seem to come from the upper part of the ilio-pectineal line, which may represent the small, distinct muscle of the Orang, described by Prof. Owen as coming from the fore part of the ilium, and inserted at the root of the trochanter minor. The *Psoas* is blended with the *Iliacus* in the whole length of the latter, and both continue fleshy quite to the insertion.

Iliacus. See *Psoas magnus.*

Scansorius, (Traill). This muscle arises from the whole outer border of the ilium, nearly as far down as the acetabulum, and is inserted into the lower part of the great trochanter, between the origins of the *Vastus externus* and *Cruræus*. It would rotate the thigh a little inward from its usual position, but its use is most obvious as an extra flexor of the thigh; it is a rather thin, but fleshy and perfectly distinct, broad, triangular muscle, but so far as I can learn, it has been found only by Traill, who first discovered it in his Chimpanzee, and by Prof. Owen in his Orang. When its use is so apparent, it is strange that it should be so rare, and so variable in the same species.

Rectus femoris anticus. See *Quadriceps femoris.*

Tensor vaginæ femoris. This was larger than in man, and continuous with the upper thin portion of the *Glutæus maximus*. Like the *Rectus*, it would help to flex the thigh.

Glutæus maximus. Arises from the border of the lower half of the sacrum and coccyx, from the fascia covering the *G. medius*, from the great sacro-sciatic ligament, and from the tuberosity of the ischium in close connection with the long head of the *Biceps*. The upper part of the mus-

cle is very thin, and chiefly joins the *Tensor vaginæ femoris;* but the lower portion, especially that from the ischium, is very thick and strong, and inserted upon the whole length of the femur from the base of the great trochanter to the outer condyle, at which point it thickens and widens some of its fibres seeming to mingle with those of the *Vastus externus.* This ischial portion in the Gorilla is described by Duvernoy under the name of "*Ischio-femorien.*" Acting alone, it would rotate the thigh outward, so as to allow the sole of the foot to be turned inward, after which it would assist the *Adductors* in keeping the foot close against the object grasped in climbing, but acting with the *Glutæus medius*, it would help to extend the thigh.

Glutæus medius. As in the Quadrumana generally, this is the largest of the three *Glutæi*, being long and thick from the length and posterior concavity of the ilium. It is attached to the tip of the great trochanter.

Glutæus minimus. A thin, flat, radiated muscle covering the posterior border of the acetabulum, and, I think, was attached to the great trochanter; I am not sure whether it arose at all from the coccyx.

I think there has always been some misapprehension as to the true functions and importance of the two great *Glutæi* as contrasted in man and the Quadrumana. In the latter they are generally described as small and weak; whence the inability of these animals to stand erect or upon one leg as we do. But, apart from the grave error of stating an effect for a cause, the real distinction seems to me to be not so much in the size as in the position of these muscles. Man stands or walks erect with ease, and his *Glutæi* are very large; the ape with difficulty approximates to the erect position, and it is doubtful if he is at all able to stand on one leg, whence it seems to be inferred that his *Glutæi* must be very small and weak.

But suppose we had first studied their actions in the ape; having seen that by means of them he leaps well, and knowing that man does not leap so well, the same reasoning would lead us to believe that the *Glutæi* of man cannot be very large. The truth is, that these same muscles perform two sets of movements in both man and the ape, but in the former they are so disposed, in conformity to the rest of his structure, as to be best adapted to assuming and maintaining the erect position, while in the latter their form and direction are so modified as to be more favorable to leaping. Many of the lower animals, the Horse for instance, have a very large *Glutæus medius.* Yet they never stand erect. It is the muscle with which they kick, and kicking differs from leaping only in the position of the fixed point of the action. I do not believe that the *size* alone of the *Glutæi* in the ape has any influence upon his natural attitude, but that if his body and legs were so balanced as to enable him to assume the erect position at all, the muscles as they are would have sufficient strength to maintain it, though no doubt with less steadiness than those of man. But the entire skeleton and many other points in the muscular system show conclusively that they never were designed to do any such thing; even with the great bulk of our extensors we find it extremely tiresome to stand or walk with the limbs and trunk semi-flexed, and that is the natural attitude of the ape, who is then principally supported by his long arms, the hands either resting on the earth or grasping some object. The pelvis of man is short and broad, the ischia being short and near together, allowing the limbs to swing freely by them. The *Glutæus maximus* lies about equally above and below the socket or centre of motion. But in the Quadrumana, and in most of the lower animals, the ischia are lengthened and spread out, since the legs do not swing behind them; the *Glutæi maximi* arise chiefly from the

tuberosities, and are inserted generally much lower on the femur than in man, their increased length enabling them to contract through a longer space, and they are thus powerful retractors of the whole limb to a certain extent, though not so as to bring it into line with the trunk, however strong they may be. In man the external surface of the short, broad ilium looks outward like the acetabulum, and the fibres of the *Glutæus medius* converge from their broad origin to the great trochanter; the entire arrangement being such that the muscle acts to prevent the body from sinking to one side when supported by the opposite leg, and also, from the great breadth of its origin to assist the *Glutæus maximus* and *Psoas* in preserving the balance forward and backward, which also is required in ordinary progression. But in the ape the external surface of the ilium looks upward or backward, while the acetabulum still looks outward as in man, thus at right angles with that surface; the ilia are long and narrow, so that the fibres of the *Glutæus medius* run nearly parallel to each other, and the muscle is inserted at the end, not, as in man, down the outer side of the trochanter, upon which in the flexed state of the femur the muscle acts as upon the short arm of a lever of which the leg is the long arm; just as in man when the femur is flexed, though to more advantage, on account of its attachment to the tip of the trochanter. It also tends to rotate the limb inward, which, when simple extension is required, is counteracted by the simultaneous contraction of the *Glutæus maximus*, which rotates in the opposite direction. It appears, then, that the peculiar attitude of the ape is not connected with the *size* alone of the *Glutæi*, but that since he was not designed to stand or walk erect, or to rest on one leg, his entire frame is constructed not for those, but for another set of movements which are subsidiary in man, but to the performance of which both skeleton and muscles in the ape are perfectly adapted.

Quadriceps extensor femoris. The *Rectus* has but a single tendon, from the inferior spinous process of the ilium, the tendon from the acetabulum being absent, as in Ateles Paniscus and in a Macacus; this peculiarity is not elsewhere mentioned. The Rectus may act as a powerful flexor of the thigh, in which case its extensor power is easily counteracted by the flexors of the leg, which are inserted so low down as to act at even more advantage than in man. Both this muscle and the scapular head of the *Triceps humeri*, of which it is the homotype, are obviously of more use to the ape as flexors than as extensors.

To lessen the jar on striking the earth, and for the more advantageous attachment of muscles, the limbs of most animals, especially those which move quickly, are constantly flexed in two or three places; to support the weight of the body without still greater flexion, the extensors are very thick and strong; in the elephant, however, whose enormous bulk would require supports of perhaps unmanageable size, the limbs are straight as in man; but the legs of the ape are constantly bent, and yet his extensors are not even so strong as in man, showing that the greater portion of his weight must be supported by the arms in front.

The employment of the ape's foot as an organ of prehension requires an extent and freedom of motion at the knee far beyond that exercised by man; the movements must also be more prompt and easily executed; this is provided for by the low insertion of the flexors on the tibia, and by the length of the fleshy portion of the muscles, depriving the *Semi-Membranosus* and *Semi-Tendinosus* of the characters which gave them their names in Human Anatomy. The reverse is the case in the leg of the common Quadruped, the Dog or the Cat; in them the movements are simply forward and back, quick and forcible, but limited; the muscles therefore are very thick and

strong, but short, and the limbs are sharply bent at the joints. But this mass of muscle about the limb would be wholly inconsistent with the motions of the prehensile foot of the ape, or even a baboon, in whom therefore the muscles are comparatively long and slender. The limbs of the Quadrumana are also projected further from the trunk than in the lower animals. In man the leg can be rotated at the knee only in a state of semi-flexion; this is the constant attitude of the ape's leg, and the rotation is very free. The short head of the *Biceps* would act as an external rotator in the Anthropoids, but in the Mandrill I do not think it exists, and in Quadrupeds generally it is wanting as such, though there is sometimes a slender slip from the pelvis.

Sartorius. Very long, from the great height of the ilium; it is inserted by a very short, fascia-like tendon on the front of the tibia, at least one third from the knee, over the *Gracilis*. The *Gracilis* is proportionally much thicker and stronger than in man.

Semi-membranosus. Tendon of origin long, that of insertion shorter, but attached as in man. The tendon of the *Semi-tendinosus* joins that of the *Gracilis*, and is inserted beneath it. Biceps. The long or ischiatic head is proportionally smaller than in man, and absolutely smaller than the *Gracilis* and *Semi-tendinosus*. The short head arises as in man, and joins the other at the knee, forming a very strong fascia which extends over the fibula nearly to the ankle, the tendon of the long head sending a strong prolongation to the outer tuberosity, as in man. The two heads were inserted thus together in the Chimpanzees of Traill and Vrolik, but separately in the Gorillas of Wyman and Duvernoy, and in Owen's Orang. When on all-fours, these last three muscles would also help retract the leg; in a Cynocephalus the *Biceps* was also attached above the joint to the patella, and in the Dog, where the

motion is simple retraction of the whole limb, the *Semimembranosus* also is inserted into the patella, thus giving a broader attachment, when the separate flexion of the limb below the joint is not required. Like the *Glutæi*, these three muscles also serve to support the trunk on the legs in one direction, while the *Gracilis* and *Sartorius* antagonize them in front; their great size causes me to think, as in the case of the *Glutæi*, that if the trunk could be balanced they would be able to maintain it erect, though probably with not so much steadiness, on account of the heaviest part of the body being so far above the pelvis, and not in and about it as in man. The *Popliteus* is not constant; in this individual I think it was rather thicker than in man, but I did not find the cartilaginous nodule in the external lateral ligament where the muscle arises. Traill and Tyson could not find the muscle, but it was present in Vrolik's Chimpanzee, and in the Gorillas of Wyman and Duvernoy. Its action as a rotator inward would be balanced by the short head of the *Biceps*, which rotates outward.

Gastrocnemius and Soleus. These are much thinner than in man, but continue fleshy to their insertion; the latter has but one, the external head, as is generally the case in the Quadrumana. The two unite at about two thirds way down from the origins; the place of this union varies in different species, and often considerably in individuals of the same species; I do not see that the place of union, or the absence of the internal head of the *Soleus*, would have much effect upon the motions of the foot.

Plantaris. This was absent on the left side, and very small on the right side of this Chimpanzee; it was present in those of Vrolik and Tyson, but absent in that of Traill, in the Gorillas of Wyman and Duvernoy, and in the latter's Orang, in the Howling-Monkey and Ateles Paniscus. Not constant in the Cynocephali.

In man the *Glutæi* and long flexors of the leg have two sets of functions according as they take their fixed point from above or from below, that is, as they are used either for moving the legs by themselves as mere appendages, or for acting powerfully upon the trunk as in locomotion, and maintaining the erect position on one or both legs. In the ape, these positions not being required, the muscles are employed in locomotion and in leaping as we have seen above, but chiefly for moving the prehensile limb with any object which may be in its grasp; they are therefore modified not so much in size as in position, in which latter respect we remark the evidence as to the intended semi-erect attitude of these animals. With the *Gastrocnemius* and *Soleus* the case is otherwise. They also perform two different functions according as they act from above or from below; but in man their great strength is almost wholly employed after the latter manner, for raising and balancing the body upon the foot, while the movements of the foot on the leg are limited, and require little power. The body of the ape is not designed to be balanced upon the foot in his usual attitude, and in walking he lifts the foot as a part of the leg without much motion at the ankle. So in the ape the *Gastrocnemius* and *Soleus* are much more slender than in man, but their muscular portion is longer, in adaptation to the less powerful but more extensive and free movements of the prehensile foot. In most Quadrupeds, again, which rest on the ends of the toes or metatarsal bones, these muscles must be powerful like the extensors of the other segments of the limb. Thus we see that the semi-erect attitude of the ape is indicated by the modification as to *position* of the *Glutæi* and long flexors of the leg, but by a difference in *size* of the extensor muscles of the foot.

Tibialis anticus. This muscle is thicker than in man, and continues fleshy lower down. In the Quadrumana

generally, the division at the insertion, of the tendon into two parts is continued up so as to make two muscles more or less distinct. In the Gorilla of Duvernoy this division existed only a little above the ankle, but in this Chimpanzee the two parts were distinct above the middle of the leg, and the posterior or internal portion which is attached to the internal cuneiform bone was three times as large as the other. In Vrolik's specimen this portion arose upon the fibula. The anterior portion which goes to the metatarsal bone is called by Prof. Wyman "*Tibialis anticus minor*," and by Meckel "*Abductor longus proprius pollicis pedis*." The division evidently accords with the use of the great toe as a thumb.

Peroneus longus and Peroneus brevis. These are not so distinct as in man. The former would act as a flexor of the great toe, which enjoys considerable motion at the tarso-metatarsal articulation; there was a sesamoid bone in its tendon as in man. From the external border of the tendon of the *P. brevis* near its insertion a slender but strong fascia ran along the border of the metatarsal bone, and was connected above the knuckle with what seemed to be a remnant of the extensor fascia of the little toe.

Extensor longus digitorum. Origin and insertion as in man. In Tyson's Chimpanzee there was no tendon to the little toe, and in Owen's Orang none to the second toe. I find that at the time of my dissection I made no note of the ligament described by Vrolik, through which run the tendons of the *Extensor longus digitorum*, and now I have no recollection of it, though I presume it was present; and Mr. Moore says the muscle on the right side passed through a separate loop just in front of the astragalus. In a small Macacus now before me, the real annular ligament is attached to the fibula higher than to the tibia, and not at all to the calcaneum; and there is also a perfect loop for the *Extensor digitorum*, of which both

ends are attached close together on the upper border of the calcaneum. This loop is one third of an inch long, and freely movable after the fascia has been taken away. I should think that the position of the annular ligament wholly above the joint, and of this extra loop wholly below, would better enable the muscle to act, not only as an extensor of the toes, but also more freely as a flexor of the foot, when also the insertion of the loop on the outer edge of the calcaneum would perhaps supply the place of the *Peroneus tertius.*

Peroneus tertius. So far as I know, this has been found in the Quadrumana only once, in the Howling-Monkey, by Prof. Wyman, where, however, instead of being a flexor of the foot, it passed beneath the outer malleolus, and was inserted into the base of the little toe, which it would serve to extend.

Extensor proprius pollicis. Probably present, though I neglected to make a note of it; on the right side as in man.

Tibialis posticus. Origin and insertion apparently as in man, but I saw no sesamoid bone near the insertion. In Owen's Orang it was inserted into the internal cuneiform, and in Ateles Paniscus into the scaphoid bone only. It is usually more slender than in man.

Flexor longus digitorum. Arises as in man, but continues fleshy to the ankle, below which it divides into two tendons, which are inserted into the distal phalanges of the second and fifth toes. The *Musculus accessorius* is inserted into the external border of this muscle, and from the tendon arise the three fasciculi of the *Lumbricales Flexoris longi digitorum.* The disposition of the tendons of this muscle, and of the *Flexor longus pollicis*, is various in different individuals and species.

Flexor longus pollicis. This is a large, strong muscle arising as in man and continuing fleshy to the joint, where

it forms a broad tendon which divides into three, which are inserted into the distal phalanges of the first, third, and fourth toes, as in the Chimpanzees of Vrolik and Traill, and in Duvernoy's Gorilla; the tendon of the first toe passes through a separate strong loop at the base of the metatarsal bone. In Owen's Orang the great toe received no tendon from either of the long flexors, but in the Howling-Monkey the great toe received the single tendon of the *Flexor longus pollicis.* In dissecting the Ateles Paniscus, both Mr. Folsom and myself at first described this muscle as the *Flexor longus digitorum*, being deceived by its great size, and the number of its tendons. The tendons of the two muscles before their subdivision are firmly connected by a whitish substance. As in Owen's Orang, bending the foot up against the leg caused a mechanical flexion of the toes which would materially increase the firmness of the foothold upon a branch.

Flexor brevis digitorum. Arises as in man, but has only two tendons, which are inserted into the middle phalanges of the second and third toes.

Flexor accessorius. Has but one, the external head, which is joined to the outer border of the *Flexor longus digitorum.* Both this and the *Flexor brevis* vary considerably in different species, and also in different Chimpanzees.

Lumbricales Flexoris longi digitorum. Three fasciculi arising upon the tendon of the *Flexor longus digitorum;* the inner one is attached to the inner border of the first phalanx of the second toe, the middle one joins the tendon of the *Flexor brevis*, to be inserted into the second phalanx of the third toe after being perforated by the tendon of the *Flexor longus pollicis*, and the third or outer fasciculus is also perforated by a tendon of the same muscle, and is then attached to the second phalanx of the fourth toe.

Lumbricales Flexoris longi pollicis. Also three fasciculi arising between and on both sides of the two tendons

of the *Flexor longus pollicis*, and inserted into the inner borders of the bases of the first phalanges of the third, fourth, and fifth toes. Thus each toe receives a tendon from a long flexor to its third phalanx, the four outer toes each a Lumbricalis to the base of the first phalanx, the second, third, and fourth each a tendon from a short flexor to the second phalanx, and that of the third toe is also joined by a tendon from a long flexor; the first and fifth toes having peculiar short muscles of their own, receive fewest tendons from the common flexors, and of the other three the middle one is naturally best provided. (See Table.)

On the following Table, the asterisks indicate the insertion of tendons of the muscles named at the left, into the base of those phalanges of those digits against which they respectively stand; thus exhibiting the distribution of the tendons of each muscle, the tendons which each digit receives, or the tendons which are inserted into any one phalanx.

	MUSCLE.	MAN. 1st digit.	2d digit.	3d digit.	4th digit.	5th digit.	TROGLODYTES NIGER. 1st digit.	2d digit.	3d digit.	4th digit.	5th digit.	Phalanges.
Long flexors.	Flexor longus digitorum		*p'g[1]	*p'g	*p'g	*p'g		*p'g			*	3d
												2d
												1st
	Flexor longus pollicis	*					*		*p'g	*p'g		3d
												2d
												1st
Short flexors.	Flexor brevis digitorum											3d
			*p'd[2]	*p'd	*p'd	*p'd		*p'd	*p'd[3]			2d
												1st
	Lumbricales Flexoris longi digitorum											3d
									*p'd	*p'd		2d
			*	*	*	*		*				1st
	Lumbricales Flexoris longi pollicis											3d
												2d
									*	*	*	1st

From the above Table it will be at once remarked, that in the human foot there are three muscles distributed uniformly to the corresponding phalanges of the four lesser

[1] P'g = perforating. [2] P'd = perforated.

[3] This tendon joins that of the Lumbricales Flexoris longi digitorum, and is inserted with it.

digits, which latter also are of nearly equal power and importance; while in the foot of the ape, this uniformity does not exist, and the digits are more independent of each other, the middle one being the strongest, as in the hand of man, in adaptation to the prehensile function of the member.

The *Interossei* on the dorsal and plantar surfaces were not very distinct from each other, but the latter far exceeded the former in size.

Extensor brevis digitorum. In the Quadrumana this consists of only three fasciculi, supplying the second, third, and fourth toes as in man, the fasciculus supplying the first or great toe being so distinct from the rest as generally to be considered a separate muscle; this is apt to cause confusion in comparing dissections by different authors; Traill says the *Extensor brevis digitorum* sent tendons to all the toes, but Tyson says it was wanting altogether. (?)

Extensor brevis pollicis. Forms a distinct muscle in most of the Quadrumana; it is inserted as in man, but has a more oblique direction on account of the angle which the great toe forms with the side of the foot.

Flexor brevis pollicis. Consists of two fasciculi as in man, the tendon of the *Flexor longus* running between them. I did not note the origin of the internal head which is inserted with the *Abductor pollicis*, but the external or deep-seated portion appeared to come from the internal cuneiform and partly from the metatarsal bone, and the two heads were rather more distinct than in man. Vrolik describes but one fasciculus, but generally there are two. In Owen's Orang, the channel usually filled by the tendon of the long flexor was occupied by a small, short flexor arising upon the metatarsal bone, and inserted into the first phalanx.

Abductor pollicis. A strong muscle, arising, so far as I could see, upon the calcaneum alone, and inserted as in man with the internal head of the *Flexor brevis*, which

indeed is far more closely connected with it than with the external head. From the small size and more outward position of the calcaneum, and the divergence of the great toe, this muscle would act rather as a direct *flexor* and *adductor* than as an *abductor*. Vrolik says there was a smaller fasciculus from the internal cuneiform, which perhaps represented the internal head of the Flexor brevis, of which he says there was but a single head. In the Howling-Monkey the Abductor consisted of two parts, the one from the calcaneum being the more distinct, and acting as a flexor.

Adductor pollicis obliquus. Corresponds to the single muscle in man, but is very much larger and more nearly transverse; it arises as in man, and is inserted into the first phalanx of the great toe, as in Vrolik's Chimpanzee and in Duvernoy's Gorilla and Orang. Traill makes no division into two, but seems to include both this and the *Adductor transversus* as one large muscle extending nearly the whole length of the second metatarsal. The *Adductor pollicis transversus* appears to arise from the heads of the second, third, and fourth metatarsals, and is thinner than the preceding; it is attached to all the bones of the great toe from the head of the metatarsal inclusive, as in Duvernoy's Gorilla and Orang. Vrolik says it came from the fifth metatarsal. The *Transversalis pedis* is either unmentioned or declared absent by all the authors, excepting perhaps Duvernoy. There is none in this Chimpanzee, unless the *Adductor transversus* represents it, as it certainly does pretty nearly in position and action.

Flexor brevis minimi digiti. Has its origin and insertion as in man. The *Abductor minimi digiti* arises as in man, but seems to consist of two not very distinct portions, of which the internal is long and fleshy, and inserted into the base of the second phalanx as in the right foot, and as in Vrolik's specimen; while the external is small,

and attached to the base of the fifth metatarsal. Neither Traill nor Tyson mention this peculiarity.

Perhaps I can add nothing to what has been said by others, of the great contrast in function, and thence in structure, between the extremities of man and the ape. In the latter the hand is chiefly an organ of suspension, composed of four strong, flexible hooks, which, even when the member is employed as a hand, are flexed all together, the short, feeble thumb, so nearly in the same plane with them, not being opposable to the individual fingers. The foot is the organ of prehension, being broad, the great toe standing out as an efficient thumb, with large and distinct muscles; and even when used simply for supporting the body on a branch, the whole foot forms a flexible tripod far more serviceable than the stiff narrow foot of man.

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